

SECTION 4

CONSTRUCTION STANDARDS

4.1 INTRODUCTION. This section sets forth the requirements for earthwork, pipeline construction, roadway construction, chip seals, slurry seals, concrete work and restoration of surface improvements.

4.2 SURVEY REQUIREMENTS. Prior to commencing the work, all construction shall have appropriate construction staking in conformance with the approved drawings unless otherwise approved by the County representative. The staking shall have all necessary information including, but not limited to, stationing, cut or fill data, off-set distance and invert elevations. The information shall be placed on the face of stakes in a legible manner using weatherproof marking materials and shall be in accordance with general surveying practice. All construction staking shall be under the direction of the Engineer responsible for the project.

When a water main design has a profile with grades, a grade line will be staked at the designated grades prior to installation of any pipe. A laser may be used in lieu of a grade line. All sewer lines and storm drains will require that a grade line, or laser, be set and checked prior to installation of any pipe.

4.3 EARTHWORK. This subsection defines the requirements for excavation and backfill for structures, preparation of embankments and fills, and subgrade preparation for pavement and other surface improvements.

4.3.1 MATERIALS. Earthwork materials shall conform to the following:

4.3.1.1 EXCAVATION. All structures shall be founded on prepared original soil or engineered fill. Unauthorized excavation below the specified structure subgrade shall be replaced with concrete, untreated base course, or approved engineering fill thoroughly compacted to a minimum of ninety-five (95) percent of maximum dry density. Subgrade soil for all concrete structures, regardless of type or location, shall be firm and thoroughly compacted to a minimum of ninety-five (95) percent of maximum dry density for granular soils or ninety (90) percent of maximum dry density for silty/clay (fine-grained) soils, as measured by modified proctor.

4.3.1.2 SUBSOIL REINFORCEMENT. Coarse gravel, crushed stone, or a geotextile may be used for subsoil reinforcement when approved by the County representative. Coarse gravel or crushed stone shall be applied in six (6) inch layers, each layer being embedded in the subsoil by thorough tamping. Approved geotextile shall be installed in accordance with manufacturer's recommendations. All excess soil shall be removed. The finished elevation of any subsoil shall not be above the specified sub-grade elevation.

4.3.1.3 BACKFILL. Backfill shall be placed to the lines and grades shown on the approved drawings, or as directed by the County's Representative. Prior to backfilling any construction work, the excavation shall be cleaned of all forms, trash and debris, and such material shall be removed from the site. Backfill material shall be approved and consist of excavated material or clean imported materials such as sand, gravel or other suitable material.

Backfill shall be placed in layers compatible with the equipment and not exceeding six (6) inches in compacted thickness. Each layer shall be compacted to a minimum density of ninety-five (95) percent of maximum dry density for granular soils or ninety (90) percent of maximum dry density for silty/clay (fine-grained) soils, as measured by modified proctor.

4.3.2 CONSTRUCTION METHODS. The methods employed in performing the work shall be the responsibility of the Contractor. These methods shall include, but are not limited to, the following:

4.3.2.1 CONSTRUCTION OF EMBANKMENTS. Unsuitable materials that occur in the foundations for embankments shall be removed by clearing, stripping and/or grubbing. When required by the County representative, the embankment and the materials used shall be approved by a Geotechnical Engineer. All materials in embankments shall be placed, moistened, and compacted as outlined in the following paragraphs.

When the material needed for embankment exceeds the amount of material available from excavation, sufficient additional materials shall be provided by the Contractor. All materials used for embankment construction shall be free from deleterious materials and rocks larger than three (3) inches in diameter and all other material unsuitable for construction of embankments. Rocks larger than three (3) inches may be used when recommended by the Geotechnical Engineer and approved by the County representative.

Grading of completed embankments shall bring the surfaces to a smooth, uniform condition with final grades being within 0.1 foot of the design grade. Cut and fill slopes shall be a 2 horizontal to 1 vertical maximum (2h: 1v). Construction of slopes steeper than 2h: 1v or fills in excess of five feet, or when placement is on a slope of greater than 5h: 1v shall be reviewed and recommended by the Engineer.

4.3.2.2 COMPACTION OF EARTH MATERIALS. The fill material shall be deposited in horizontal layers having a thickness of not more than eight (8) inches and then compacted to the density as herein specified. Moisture content during compaction operations shall be within two percent (2%) of optimum for granular soils and shall be two to five above (2%-5%) optimum for fine-grained soils unless otherwise directed by the Geotechnical Engineer. The moisture content shall be uniform throughout the layers.

If the moisture content is greater than specified for compaction, the compaction operations shall be delayed until such time as the material has dried to the specified moisture content. When the material has been conditioned as herein specified, the backfill or embankment shall be compacted as directed below.

Under roadways, curb and gutter, sidewalks and driveways, and extending two (2) feet beyond the proposed construction (or to a distance equal to the depth of the embankment material, whichever is greater), the embankment material shall be compacted to a density equal to not less than ninety five (95) percent for granular soils and ninety (90) percent for fine-grained soils. Other fills and embankments not noted above shall be compacted to ninety (90) percent maximum dry density.

Exposed natural soils within construction areas, beneath walkways, slabs and pavement shall be scarified to a depth of twelve (12) inches; moisture conditioned, and compacted to the specified density. Where rock or other acceptable material is exposed, scarification may not be necessary.

Foundations for structures shall be uniform throughout and shall not be placed partially on undisturbed soil or compacted fill and partially on cemented deposits or rock.

Foundation soils should not be allowed to become saturated during construction.

4.3.2.3 SUBGRADE PREPARATION. As a minimum, the original soils under roadways curb and gutter, sidewalks, and driveways shall be scarified to a depth of one (1) foot prior to compaction operations. All scarified soils shall be compacted to the equivalent of ninety five (95) percent of maximum dry density for granular soils or ninety (90) percent of maximum dry density for fine grain soils. Additional overexcavation and recompaction of original soils due to poor subgrade conditions may be required. Subgrades shall be shaped and graded to the design grade. Drainage shall be maintained at all times. Subgrades shall be stabilized and compacted as directed. When springs or underground water is encountered during construction the Engineer and the County's Representative shall be notified immediately. Work shall not proceed until an acceptable mitigation plan is approved. Ground water discovered during construction shall not be ignored.

The subgrade preparation requirements listed above are considered to be the minimum. When required, the subgrade shall be overexcavated and the material removed from the site. Select borrow material may be imported, placed and compacted as directed by the County's Representative.

To demonstrate the stability and compaction of the subgrade, the Contractor may be required to proof-roll the subgrade prior to placing any base gravel.

The subgrade shall be proof-rolled with at least one pass coverage with a roller with pneumatic tires or other acceptable equipment of at least ten (10) ton capacity. All proof-rolling shall be accomplished in the presence of the County's Representative. Ground contact pressure for all tires shall be eighty five to ninety (85-90) psi unless otherwise recommended.

When the proof-rolling shows an area to be unstable, it shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material.

4.3.2.4 CONSTRUCTION OF NON-STRUCTURAL FILLS. Fills shall be placed to the lines and grades shown on the approved drawings and shall include all areas not specifically designated for support of structures, roads, utilities, easements, drainage ways, etc. (such as landscape areas, open space areas, etc.). Fill material shall generally be compacted to a minimum of ninety (90) percent of maximum density and shall consist of material that can be compacted to prevent settlement such as soil, rocks, blocks, crushed stone, broken concrete, etc. Fill material shall not include broken asphalt, toxic or hazardous materials waste sludge, deleterious materials such as muck, ash, sod, grass, trash, tree stumps, lumber, dead animals, etc.

4.3.3 QUALITY CONTROL. All earthwork shall be performed in accordance with these standards and shall be tested and accepted as follows:

4.3.3.1 TESTING. Minimum testing of earthwork shall be as follows:

Soil Classification - One per material source. Soil classifications shall be in accordance with AASHTO M-145. For determination of granular soils or fine grained soils use ASTM D-2487 (Unified Soil Classification System). The sieve analysis shall be according to ASTM C-136 and C-117.

Soil Proctor - One determination for each significant change in soil type as necessary to provide required compaction testing. Tests shall be ASTM D-1557 method A or D (modified proctor).

Earth fill moisture/ density determination - One test per five hundred (500) cubic yards of fill placed in an embankment. Tests shall be ASTM D-1556 or D-2922 and D-3017.

Subgrade moisture/ density determination - One test per seven hundred fifty (750) square yards of surface area. Tests shall be ASTM D-1556 or D-2922 and D-3017. Additional moisture density determinations may be made when required by the County's Representative.

4.3.3.2 ACCEPTANCE. Any earthwork determined not to be in compliance with these standards shall be removed and replaced or reworked until compliance is obtained. Costs for the rework or testing the

rework shall be paid for by the Contractor.

4.3.4 SPECIAL REQUIREMENTS. The requirements outlined in this section are only a minimum. When a geotechnical investigation is required, the recommendations of the geotechnical report shall be followed unless said recommendations are less than minimum standards.

All development projects shall submit a final soils engineering and engineering geology report in accordance with the County's applicable Building Code.

4.4 PIPELINE CONSTRUCTION. This subsection covers the requirements for materials, trenching, placing, backfilling, cleaning, testing and other miscellaneous requirements for underground pipeline construction and associated work. This section incorporates the requirements of the AWWA Standards and the Manufacturer's Recommended Installation Procedures, whichever is more stringent.

4.4.1 MATERIALS. This subsection specifies the acceptable materials for pipeline construction for use in sanitary sewers, underground culverts, storm drains, water pipes, and appurtenant construction. All materials shall be new and conform to the requirements for class, brand, size and material as specified herein. All materials shall be stored and handled in accordance with manufacturer's recommendations.

4.4.1.1 SEWER PIPE AND FITTINGS. Only those pipe materials listed below may be used in the construction of sanitary sewer line unless otherwise approved in writing by the County representative.

A. POLYVINYL CHLORIDE (PVC) PLASTIC SEWER PIPE. This specification covers rigid polyvinyl chloride (PVC) pipe and fittings. PVC pipe and fittings from four (4) inches to fifteen (15) inches in diameter shall meet or exceed all of the requirements of ASTM D-3034 with a minimum wall thickness to diameter ratio of SDR-35. PVC pipe and fittings from eighteen (18) inches to twenty seven (27) inches in diameter shall meet or exceed the requirements of ASTM F-679.

Each pipe shall be stamped by the manufacturer indicating compliance with the requirements of the appropriate specification. Any pipe not so stamped shall be rejected.

All pipe and fittings shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. All PVC pipe and fittings shall be made from clean, virgin, Type 1, Grade 1, Polyvinyl Chloride conforming to ASTM D-1784.

All pipe joints shall be bell and spigot type with flexible elastomeric seals in accordance with ASTM F-477. Pipe and fittings shall be assembled with a non-toxic lubricant. Pipes of four (4) inch diameter may be the

solvent weld type, in accordance with ASTM F-656 for primer and ASTM D-2564 for glue. Pipe shall have the following minimum SDR-35 dimensions.

**TABLE 4.1
SEWER PIPE DIMENSIONS**

Nominal Pipe Size (Inches)	Outside Diameter (Inches)	Minimum Wall Thickness (Inches)
4	4.215	0.125
6	6.275	0.180
8	8.400	0.240
10	10.500	0.300
12	12.500	0.360

Spigot ends shall have a fifteen (15) degree tapered end with a memory mark around the diameter of the pipe to indicate proper insertion depth. Fittings shall be of the same material as the pipe, and shall not have a wall thickness less than that of the pipe furnished.

B. A.B.S. COMPOSITE AND SOLID WALL SEWER PIPE. This specification covers Acrylonitrile-Butadiene-Styrene (ABS) gravity sewer pipe.

All ABS composite sewer pipe shall conform to the latest revision of ASTM Specification D-2680. The ABS material used shall be a virgin rigid plastic conforming to ASTM Specification D-1788 for rigid ABS plastics. The other component shall be Portland Cement, Perlite concrete or other inert filler material exhibiting the same degree of performance.

All solid wall ABS pipe shall conform to ASTM Specifications D-2751. Solid wall pipe used for laterals shall have a minimum wall thickness to diameter ratio of SDR-35. Fittings not described by these standards shall be shop fabricated or molded from materials listed in paragraphs 4 and 5 of ASTM D-2680 and shall be of equivalent quality to those described.

All field joints shall be chemically welded. Primer, then cement, shall be applied liberally to the outside of the spigot end and the inside of the coupling immediately prior to stabbing the pipe together. The pipe spigot end shall be supplied with home marks to assure proper jointing.

C. NON-REINFORCED CONCRETE PIPE. Non-reinforced concrete sewer pipe may be used up to and including twenty-four (24) inch size, unless otherwise designated by the County representative or these specifications. Appropriate design justification shall be submitted by the

Engineer to the County for review and approval prior to use. Pipe shall be extra strength and manufactured to comply with the requirements set forth in ASTM Designation C-14, Class 3 unless otherwise approved by the County representative. Type V cement shall be used unless otherwise approved. Joints shall be of the bell and spigot-type with rubber gasket design, and with joints and gaskets conforming to the requirements of ASTM Designation C-443. Pipe joints shall be so designed to provide for self-centering, and when assembled the gasket shall compress to form a water-tight seal. The gasket shall be confined in a groove on the spigot so that pipe movement or hydrostatic pressure will not displace the gasket.

D. REINFORCED CONCRETE PIPE. Reinforced concrete pipe may be used for all appropriate applications. For pipe greater than twenty-four (24) inches in diameter, and where any non-reinforced concrete pipe installation does not provide a cover of at least three (3) feet over the top of the pipe, reinforced concrete pipe shall be used. Reinforced concrete pipe shall comply with the requirements of ASTM C-76 (Class II - V) unless otherwise approved by the County representative. Type V cement shall be used unless otherwise approved. Joints shall be of the bell and spigot design with rubber gasket type joints, with an alternate option of tongue and groove joints for storm drain lines when approved by the County representative.

4.4.1.2 STORM DRAIN PIPE. Pipe listed under Sections 4.4.1.1 A. C. and D. "Sewer Pipes" of these standards, as well as the following pipes, may be used in the construction of storm drain lines and culverts.

A. CORRUGATED POLYETHYLENE PIPE. Corrugated polyethylene pipe shall be high density polyethylene corrugated exterior with a smooth interior wall. Eight to ten (8-10) inch diameters shall meet the requirements of AASHTO M-252 and have a smooth interior liner. Twelve to thirty six (12-36) inch diameters shall conform to AASHTO M-294 Type S. Forty-two to forty-eight (42-48) inch diameter shall conform to AASHTO MP-6 type. Materials shall conform to ASTM D-3350. All pipe joints and fittings shall be water tight and conform to AASHTO M-353 or M-294, and shall be approved by the County's Representative.

B. CORRUGATED ALUMINUM PIPE: Corrugated aluminum alloy pipe shall conform to AASHTO designation M-196. Any aluminum alloy to be in contact with concrete shall first be spray or brush coated to a minimum thickness of 0.05 inch with an asphalt-fiber compound conforming to the requirements of Section 702 of the State of Utah Standard Specifications for Road and Bridge Construction. The aluminum alloy shall be thoroughly cleaned, including the removal of oil and grease, and shall be dry prior to treatment. Pipe installation and appurtenances shall conform to UDOT Standard Specifications.

C. CORRUGATED STEEL PIPE. Use of corrugated steel pipe shall require pre-approval from the County Representative and shall be on a case-by-case basis.

Corrugated steel pipe shall be in conformance with AASHTO M-36 and other applicable AASHTO standards as required. Smooth flow spiral rib pipe shall generally be used in storm drain applications while other applications may require annular or helical corrugations. Pipes shall be fabricated with a continuous lock seam or ultra high frequency resistance welded seams.

(1) **COATINGS.** All pipe shall have an aluminized coating, both sides, in accordance with AASHTO M-274 specifications unless otherwise approved. The pipe shall be fabricated from steel coils that have been hot-dipped coated in a bath of commercially pure aluminum. This coating shall be uniform throughout on both sides of the sheet and be metallurgically bonded between the metals. When a polymer coating is approved for use, such coating shall be a minimum of 10 mils in thickness and shall be a two-sided coating and shall conform to AASHTO M-245. When a galvanized coating is approved for use, such coating shall be hot dipped in accordance with AASHTO M-245. The coating shall be on both sides. Other coatings and linings may be approved.

(2) **JOINTS.** All joints shall have the same base metal and coating as the pipe being joined. Joints shall provide circumferential and longitudinal strength to preserve the pipe alignment, to prevent separation of the pipe, to prevent infiltration of fill material and to provide water tight joints. O-ring gaskets or other acceptable material shall be used.

(3) **FITTINGS AND ACCESSORIES.** All fittings, bolts and accessories shall meet applicable specifications of the pipe being used. Use accessories and gaskets recommended by the manufacturer.

(4) **INSTALLATION.** Installation shall be in accordance with the manufacturer's recommendations and these specifications.

NOTE: Use of this pipe may require significant testing and evaluation to determine compatibility with the ground and the intended installation. Soil Ph, resistibility and other necessary determinations should be made to ensure compatibility.

4.4.1.3 SEWER MANHOLES. This subsection covers the requirements for the materials used in sanitary sewer and storm water manholes. Manholes shall be water tight and be furnished complete with cast iron rings and covers as follows:

A. CONCRETE BASES. Manhole bases shall be either pre-cast or cast in place. Precast manhole bases shall conform to ASTM C-478. Concrete for cast in place bases shall be in accordance with Section 4.8.1 of these specifications. Type V cement shall be used for precast and cast in place bases.

Where sewer lines pass through or enter manholes, the invert channels shall be smooth and semi-circular in cross-section. Changes of direction of flow within the manholes shall be made with a smooth curve with the longest radius possible. The depth of the channel in the manhole base shall be the full diameter of the sewer pipe being used at that manhole. The floor of the manhole outside the flow channels shall be smooth and slope toward the channel in accordance with standard drawings and not less than one-half (1/2) inch per foot nor more than one (1) inch per foot.

B. WALL AND CONE SECTIONS. All manholes shall be constructed of either forty eight (48) inch or sixty (60) inch inside diameter pre-cast, sectional, reinforced concrete manholes. Both cylindrical and taper sections shall conform to the requirements of ASTM Designation C-478 for precast Reinforced Concrete Manhole Sections. All Manholes shall have ladders in accordance with the standard drawings.

Throat length of manholes shall be adjustable by use of appropriate diameter grade ring sections. The maximum height shall be eighteen (18) inches.

The taper section shall be a maximum of three (3) feet in height, shall be of eccentric conical design, and shall taper uniformly from forty eight (48) or sixty (60) inches to thirty (30) inches inside diameter. The cone shall be set on the manhole sections so all ladder rungs are aligned.

When manhole depths are less than four (4) feet manhole cones shall not be used. The manhole shall consist of a cylindrical manhole section with a precast flat manhole top in accordance with ASTM C-478.

Sixty (60) inch inside diameter sewer manholes shall be required for all sewers greater than twelve (12) inches in diameter or deeper than twelve (12) feet, or where three (3) or more eight (8) inch or greater lines converge in the manhole.

The shaft section of the manhole shall be furnished in section lengths of one (1), two (2), three (3), and four (4) feet as required. The least number of sections should be used.

Manholes larger than sixty (60) inch inside diameter may be required when designated by the County representative.

All joint surfaces of pre-cast sections and the face of the manhole base shall be thoroughly cleaned prior to setting the sections. Joints shall be sealed with a minimum one (1) inch thick flexible joint sealant which shall conform to the requirements of ASTM C-923.

C. WATER-TIGHTNESS. All manholes shall be water tight. Any cracks or imperfections shall be satisfactorily repaired. Materials and methods used shall be subject to approval of the County's Representative.

D. IRON CASTINGS. All iron castings shall conform to the requirements of ASTM A-48 (Class 30) for grey iron castings. Frames and covers shall have a minimum combined weight of four hundred (400) pounds. All castings shall be designed to carry a minimum HS-20 traffic loading.

The cover and ring seat shall be machined so that the entire area of the seat will be in contact with the cover, in any position of the cover on the seat. Frames and covers shall be so constructed and machined that the parts are interchangeable. The tops of the cover and frames shall be flush, and the clearance between the frame and cover shall be one-eighth (1/8) of an inch all around. The top surface of each cover shall be cast with a studded pattern including the word "Sewer" for sanitary application and "Storm" for storm drain applications. Letters and studs shall be raised three-eighth (3/8) inch. Each cover shall be provided with not less than twelve (12) ventilating holes of three quarter (3/4) inch diameter each.

All manhole frames shall be carefully set to the finished grade or as directed by the County's Representative. When set in roadways, walkways or other travelways, the finished manhole cover, grade, and slope shall be adjusted to match that of the traveled surface. Manhole frames shall be set in place on the manhole throat and shall be sealed with an approved flexible joint sealant which shall conform to the requirements of ASTM C-923. Frames or covers loosened from the manhole throat shall be reset and any frames, covers or throat sections damaged or broken shall be replaced prior to acceptance by the County's Representative.

E. MANHOLE STEPS. Manhole steps shall be constructed in accordance with ASTM C-478 and the standard drawings.

Manhole steps shall be installed at intervals no closer than twelve (12) inches and at evenly spaced intervals not to exceed eighteen (18) inches between steps. Steps shall be firmly installed into the concrete wall and taper sections of all manholes to a minimum depth of three and three-

eighth (3 3/8) inches, as shown in the drawings. Each step shall be solidly anchored to the wall so it will not pull out or break under repeated use. Steps shall be aligned vertically to form a continuous ladder from top to bottom.

4.4.1.4 WATER PIPE AND FITTINGS. The materials used for pipe and fittings shall all be new and conform to the requirements for class, brand, size and material as specified.

A copy of the manufacturer's installation recommendation for each type of pipe shall be provided for each construction job and shall be available on the jobsite at all times. These recommendations shall be followed during construction unless instructed otherwise by the County's Representative. All pipe materials are as outlined below.

A. GENERAL PIPE REQUIREMENTS. Pipe materials shall conform to the following requirements.

**TABLE 4.2
GENERAL PIPE REQUIREMENTS**

SIZE	TYPE
3/4"	Black or Blue Poly (HDPE) Iron Pipe Size
1" - 2"	Schedule 80 PVC <u>or</u> Black or Blue Poly (HDPE) Iron Pipe Size
Over 2"	Ductile Iron Class 51 with poly jacket sock <u>or</u> PVC C-900, Class 150 (sand bedded) see note #1 below. Black or Blue Poly (HDPE)

Notes:

1. Copper (Type K) pipe up to two 2 inches in diameter may be used upon approval of the applicable water company.
2. For pipes greater than 12 inches, material type will be determined by the applicable water company.
3. When the pipe is to be installed in a rocky area, the pipe material should be ductile iron.
4. All piping used for the purpose of irrigation only shall be purple in color.

All pipe shall conform to the current AWWA standards for each class of pipe listed above.

B. CONNECTING WATER METERS. Only authorized employees of the applicable water company shall be allowed to connect or disconnect water meters. All boxes set in concrete shall be flanged to prevent settlement.

C. DUCTILE IRON PIPE. All ductile iron pipe shall be Class 51 conforming to the latest edition of AWWA Specifications C-151 (ANSI A21.51).

C.1 JOINTS. Ductile Iron Pipe shall be either Mechanical Joints, Rubber Gasket Slip-on Joints, Flanged Joints, or a combination of the above as specified on the plans. Pipe shall also conform to all current AWWA standards.

C.2 POLYETHYLENE WRAPPING. A polyethylene wrap shall be required on all ductile iron pipe. The polyethylene wrap tubing shall be cut to provide for a minimum of one foot of lap over both the adjoining pipes. The ends of the tubing shall be wrapped using three circumferential turns of plastic adhesive tape. The loose wrap on the barrel shall be pulled snugly around the barrel of the pipe and the excess folded over at the top. This fold shall be held in place by means of six inch long strips of plastic tape placed at intervals of three feet along the pipe barrel.

Bends, reducers, offsets and restraint gland locations shall be wrapped in the same manner as the pipe. Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with adhesive tape. The valve bodies shall then be wrapped with flat sheets passed under the valve bottom and brought up around the body to the stem and fastened with the tape.

E. PVC OR HDPE PIPE. All PVC Pipe used shall meet the latest AWWA standards C-900. HDPE pipe shall meet the latest AWWA standards C-901 and C-906.

F. COPPER PIPE. Where service lines are two (2) inch or less in diameter, type K copper pipe may be allowed with prior approval of the applicable water company. Pipe which has outside dimensions greater than two (2) inches in diameter shall not be copper. All copper pipe shall conform to the current AWWA standards.

G. PIPE FITTINGS. (Two inches through 30 inches) flanged and

mechanical joint fittings shall be ductile iron class 250, and shall be produced in accordance with ANSI/AWWA C-110/A 21.10 and ANSI/AWWA C-111/A21.11 and shall conform to details and dimensions published therein. Fittings are cement lined and seal coated in accordance with ANSI/AWWA C-104/A21.04.

For large tapplings (over 2") tapped into PVC or ductile iron pipe, the following tapping sleeves are recommended subject to the approval of the applicable water company for pressures less than 125 psi:

Romac Style fts 419, fts 420
Power Seal (5 bolt), model 3480
Romac 305 Stainless Steel Service Saddle

For pressures greater than 125 psi, a mechanical joint sleeve type will be required. The following are recommended subject to the approval of the applicable water company for use.

Mueller H-615
5-149-DI
Clow F-5205
Power Seal Model 3490
Romac SST-III with ductile flange rated at 200 psi
Ford FTSS

For larger diameter pipe:

FTS-425 Class D
For HDPE - Romac SST-H

H. TAPPING MATERIAL SPECIFICATION. For small tapplings (three quarter (3/4) inch through two (2) inch) tapped into cast iron, steel, PVC, or ductile iron pipe, the following materials shall be required:

H.1 SADDLE CASTINGS. Large saddle tapplings shall be stainless steel or bronze single/double strap.

H.2 STAINLESS STEEL STRAP. The stainless steel strap shall consist of a two (2) inch wide strap and shall come complete with sufficient stainless steel or bronze bolts, nuts and washers (with five-eighths [5/8] inch N.C. Teflon coated roll threads) to properly clamp the strap to the pipe. M.I.G. welds shall be passivated for resistance to corrosion. All tapping saddles shall have a polyethylene wrapping.

H.3 GASKETS. Gaskets shall be made from virgin SBR compounded for water services.

I. **REPAIR CLAMPS.** All repair clamps shall be stainless steel and be equal to the following approved brands subject to the approval of the applicable water company:

Romac SS1-552
Power Seal 3121AS, 3122 AS

For HDPE

Romac Style SS1-H, SS2-H

J. **VALVES AND BOXES.** Unless otherwise specified by the applicable water company, all valves, twelve (12) inches and smaller, should be of a resilient-seat-gate-valve type, and all valves over twelve (12) inches should be butterfly valves.

J.1 **GATE AND BUTTERFLY VALVES.** Valves shall conform to the latest revision of AWWA valve standards.

All valves installed next to a fitting must be flange x mechanical joint (MJ) and installed with the flange end connecting to the tee, cross, or fitting and megalugged to the line unless otherwise approved by the applicable water company.

All six and eight inch valves shall have a 16"x 16"x 4" slab of concrete placed under them for support. Valves ten inches and greater shall have a 20"x 20"x 4" concrete slab placed under them for support. All support slabs shall be tied to the valves.

J.2 **VALVE BOXES.** All valves shall be provided with a cast iron valve box of the extension sleeve type or a screw type adjustable, and the height shall be adjusted to bring the top of the valve box flush with the finished surface. Extension sleeve shall be drilled or slotted and the marking wire shall be threaded through. The valve box shall not be less than five (5) inches in diameter and shall have a minimum wall thickness of .375 inch. The box shall be provided with a suitable base and cover. The word "WATER" shall be cast on the cover. Valve boxes intended for irrigation main line valves shall be triangle in shape and the word "IRRIGATION" shall be cast on the cover.

Valve boxes shall be installed plumb and properly positioned to allow access of the operating wrench. To ensure that the box is not displaced during backfill operations, the backfill shall be hand mechanically tamped for a distance of five (5) feet each way along the trench. All valve boxes shall include a concrete collar in accordance with the standard drawings with flow indication arrows.

K. WATER SERVICE LATERALS. All water service laterals shall include yoke, box and lid. The material used for water service connections shall comply with the following requirements.

K.1 SERVICE PIPE. Service pipe shall be polyethylene or copper type K as applicable.

Note: When polyethylene pipe is used, no Instatite fittings shall be used. If a service lateral becomes damaged during construction or needs to be extended, a new lateral must be installed from the main line to the meter setter. No joints will be allowed.

K.2 CORPORATION STOPS. Corporation stops shall be as manufactured by the Mueller Company, or Ford or approval equal, and shall conform to the several designations shown below for the various sizes.

**TABLE 4.3
CORPORATION STOPS**

	WATER SERVICE CONNECTION SIZE			
	3/4"	1"	1-1/2"	2"
MUELLER CO.	H-1500	H-1500	H-1510	H-1501
FORD	F600	F600	F6125	F6125

All services shall be a compression type joint for the service pipe and shall be threaded on the inlet end with an AWWA corporation stop thread.

K.3 METER SETTER YOKES. Meter setters or meter yokes shall have a built-in backflow prevention device and shall have a corrosion-resistant bronze body, dual acetyl plastic valves with natural rubber gaskets that are independently acting and capable of giving two levels of protection; stainless steel springs; a resilient O-ring end-tap seal; and full port inlet angle ball valve with brass handle. All internal parts shall be accessible without removing the valve from the line. Meters shall be installed by water company personnel only.

K.4 METER BOX AND LID. The meter boxes shall be high density polyethylene (HDPE) cast iron, or as approved by the applicable water company. Irrigation meter boxes shall be purple in color.

The meter box lids should have a hinged opening for meter reading. Lid marking shall be approved by the water company. A concrete collar shall be installed around the meter box in accordance with standard drawings.

All meter boxes shall be placed behind sidewalks in accordance with standard drawings unless otherwise directed by County's Representative.

Any meter box covered, or damaged, during construction operations shall be uncovered, replaced, and raised to finish grade by the Contractor. In areas without sidewalks, meter boxes should be flush, or one inch above the finish grade.

K.5 SERVICE CONNECTIONS. At all points designated by the water company, service connections shall be installed and shall extend from the property line to the building, unless otherwise directed by the water company.

Individual water services shall be three quarter (3/4) inch single service from the water main to the meter setter for normal domestic service. When directed by the water company, the water service shall be larger in diameter. Services shall have a minimum of three (3) feet of cover to subgrade and be constructed as shown in the standard drawings. For service laterals two inches in diameter and smaller, service saddles shall not be closer than twelve (12) inches from the end of the main, nor closer than eighteen (18) inches to any other service saddle or pipe joint.

A mechanical joint type tapping sleeve shall be used on all "hot taps". The type of mechanical joint sleeve shall be approved by the water company and the County Representative.

L. MARKING WIRE. Marking wire shall be installed on all waterline installations unless otherwise approved by the County Representative. Marking wire shall be 12 gauge solid copper with PVC or PE insulation and conform to the following:

L.1 Marking wire shall be spliced together with "grease" nuts, or equal. Prior to installation of the wire nut, a minimum amount of wire shall be bared and twisted together with pliers to assure good contact.

L.2 Marking wire shall be taped and pulled tight along the top of the pipe to ensure against breakage.

L.3 Marking wire shall extend up to all hydrants, valves and meter

boxes following service lines into meter box. At valve clusters marking wire shall be run to all valves. The marking wire shall be installed to the valve to correspond to the water line that is shut off by that valve. The wire shall be pig tailed, not looped.

L.4 Marking wire shall extend out of the valve box a minimum of twelve (12) inches.

L.5 It is the Contractor's responsibility to guarantee and show that the marking wire performs satisfactorily for its intended use. It is required that the contractor test the performance of the wire prior to installation of surface improvements.

L.6 After all the boxes are raised, the Contractor shall notify the applicable water company to perform the final acceptance testing.

M. FIRE HYDRANTS. Fire hydrants shall be a three-nozzle, five and one-half inch (5 ½") diameter Mueller, Modern Centurion, Model A-423; Kennedy, Model K-81A; or approved equal, with foot valve and six (6) inch mechanical joint connection. Fire hydrants shall conform to the latest edition of AWWA C-502, "Dry Barrel Fire Hydrants." All hydrants shall be designed for a working pressure of two hundred (200) psi and a hydrostatic pressure of three hundred fifty (350) psi. Hydrants shall be furnished with a paint finish above the ground line identical in color to the existing hydrant paint (red).

Hydrants shall be installed with a shut-off valve at the mainline. If the hydrant lateral is greater than two hundred (200) feet long, a second valve shall be installed at a location determined by the County Representative.

After the hydrant is installed and accepted, it will be the responsibility of the applicable water company to maintain the hydrant. Where applicable, the customer/property owner will allow the water company access for said maintenance.

Dead-end mains shall not be installed without prior approval of the County Representative. If installed they shall not exceed six hundred (600) feet in length. Hydrants shall be located at the end of dead-end mains for flushing purposes as well as for fire protection. Washout valves, in lieu of fire hydrants, are not allowed without prior approval of the County Representative.

Hydrants shall be of a flanged joint type or mechanical joint inlet. All hydrants shall be so designed as to allow the flanges at sidewalk level to separate without material damage to the main barrel section when struck by a large object, such as a vehicle. Upon such damage, the main gate

valve must remain closed to avoid flooding or washout. Hydrants with a nominal five inch valve opening shall be furnished with two nominal two and one half (2 ½") inch National Standard Thread Hose Nozzles and one nominal five (5") inch National Standard Thread Pumper Nozzle. All nozzles shall be furnished with a cap and gasket with attaching chain. All hydrants shall open counter clockwise with a pentagon operating nut conforming in size to the specifications of the applicable water company.

Fire hydrants shall be set to provide at least the minimum pipe cover for the branch supply line. Nozzles shall be at least eighteen (18) inches above finish grade. Each hydrant shall be set on a concrete foundation at least eighteen (18) inches square and four (4) inches thick. Each hydrant shall be adequately thrust-blocked against the end of the trench. Hydrant drainage shall be provided by installing gravel or crushed rock (¾" to 2" washed gravel) around the hydrant, and below the top of the hydrant supply line. One third (1/3) cubic yard of one and one half (1 ½") inch gravel shall be placed around the drain holes just above the hydrant valve casing. All hydrants shall stand plumb. The hydrant pumper nozzles shall face the street and be perpendicular to the curb line. The hose nozzle shall be parallel to the street. Hydrants shall be located inside the public utility easements or as otherwise directed by the County Representative. A concrete pad should be installed around the hydrant in accordance with the standard drawings.

N. PRESSURE REDUCING VALVES. Pressure reducing valve installation should be constructed as per the detail shown in the standard drawings. The valves will be as manufactured by Singer, CLA-val or equal and approved by the County Representative.

O. MEGALUG SYSTEM. A megalug retainer gland system shall be used on all mechanical joints and shall meet UNI-B-13 for PVC and be UL/FM approved through twelve (12) inch diameter for both ductile iron and PVC pipe. The restraint mechanism shall consist of individually activated gripping surfaces to maximize restraint capability. Twist-off nuts, sized the same as the tee-head bolts, shall be used to ensure proper activating of restraining devices. The gland shall be manufactured of ductile iron conforming to ASTM A536. The retainer-gland shall have a pressure rating equal to that of the pipe on which it is used (through fourteen inches) with a minimum safety factor of 2:1. Gland shall be Megalug by EBAA Iron, Inc. or approved equal. The type and model of retainer and amount for each connector is shown on standard drawings.

As an alternate to the megalug system, Ford Uniflange Series 1400 retainer glands and Series 1300 and 1390 joint restraints will be used. For PVC, Ford Uniflange Service 1500 retainer gland will be used. All other materials shall require prior approval by the applicable water

company and the County Representative.

4.4.2 CONSTRUCTION METHODS. This subsection covers the requirements for trenching, placing, and back filling of all underground pipelines (sewer, water, storm drains, etc.). The methods employed in performing the work shall be the responsibility of the Contractor. The Contractor shall make such changes in the methods used as are necessary to install an acceptable finished product. The methods shall include, but are not limited to the following:

4.4.2.1 CONTROL OF GROUND WATER. All trenches shall be kept free from water during excavation, fine grading, pipe laying, jointing, and embedding operations. Where the trench bottom is mucky or otherwise unstable because of the presence of ground water, and in cases where the static ground water elevation is above the bottom of any trench or bell hole excavation, such ground water shall be lowered and controlled to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress. Surface water shall be prevented from entering the trenches.

Dewatering for pipeline construction shall commence when groundwater is first encountered and shall continue until such time as water can be allowed to rise. Requirements of section 4.3.2.2 shall be complied with when groundwater is encountered. Dewatering shall be conducted such that no pipelines are placed in water nor shall water be allowed to rise over the pipe until the pipeline has been pressure tested and any concrete or mortar has achieved final set. Water shall not be allowed to rise in pipeline trenches or drained excavations until pipelines are backfilled or restrained to prevent flotation.

4.4.2.2 EXCAVATION FOR PIPELINES. Trench excavation shall include all operations necessary for excavation of all materials of whatever nature in relation to pipeline installation. All excavation, including the manner of support and provisions for access to trenches, shall comply with all current regulations as determined by OSHA. Trenches shall be excavated to the lines and grade shown on the drawings, and to a depth to provide the minimum required cover over the pipe unless otherwise approved by the County Representative. Pipe installation shall be in accordance with the pipe manufacturer's recommendations. The bottom two (2) feet of the trench should have vertical walls. All finish grading necessary for preparation of the trench bottom shall be made manually. Over-excavating shall not be allowed without re-compaction of backfill in accordance with these standards.

Excavation for trenches in rock shall extend to a depth of at least four (4) inches below the bottom of the pipe. Bedding material as outlined in Table 4.1 shall be placed and mechanically compacted to ninety five (95) percent of maximum dry density in maximum six (6) inch lifts to provide a smooth,

well compacted and stable foundation for the pipe or appurtenant works.

Trench bottoms shall be hand-shaped as specified and the maximum width of the trench, measured at the top of the pipe, shall be as narrow as possible, but not wider than fifteen (15) inches on each side of the pipe.

Where unstable earth, mud or muck is encountered in the excavation at the grade of the pipe, the unsuitable material shall be removed to a minimum of twelve (12) inches below grade and the subsequent hole shall be backfilled with crushed rock or gravel (as called out in Table 4.1 under "foundation material") to provide a stable subgrade. The gravel material shall be deposited over the entire trench width. The maximum layer thickness shall be six (6) inches. Each layer shall be compacted by tamping, rolling, vibrating, spading, slicing, rodding or by a combination of one or more of these methods. In addition, the material shall be graded to produce a uniform and continuous support for the entire length of the installed pipe.

Should the Contractor elect to install the pipe by boring, or jacking, approval must first be obtained from the County's Representative. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavation, and all pumping, ditching, or other approved measures for the removal or exclusion of water, including, but not limited to, storm water and waste water reaching the worksite from any source so as to prevent damage to the work or adjoining property.

The maximum amount of open trench permitted in any one location shall be two hundred (200) feet, or the length necessary to accommodate the amount of pipe installed in a single day, unless otherwise approved by the County's Representative. Open trenches shall not be allowed to stay open without proper safety precautions and barricading. Trenches should not be left open over night.

In the event "foundation material" is used in backfill, or replacement of over excavated material, the Contractor should, construct dams within the drain rock bedding material at maximum intervals of six hundred (600) feet. The dams shall be constructed to the top of the pipe or the level of groundwater, whichever is greater, with Class "B" Portland Cement Concrete or other approved material and shall have a minimum thickness of six inches.

TABLE 4.5 BACKFILL MATERIAL				
SIEVE SIZE	FOUNDATION MATERIAL	BEDDING/PIPE ZONE MATERIAL*	12" ABOVE PIPE ZONE	FINAL BACKFILL MATERIAL
	--	--		Native material which contains no sod, vegetation, rocks larger than 3" diameter, asphalt or concrete chunks, etc.
	--	--		
3"	100	--	100	
2"	90 - 100	--	70 - 100	
1"	70 - 90	100	50 - 100	
1/2"	51 - 75	80 - 100	30 - 100	
#4	31 - 65	35 - 90	25 - 80	
#16	16 - 40	20 - 45	16 - 50	
#200	2 - 12	2 - 15	2 - 20	

* 3/4" or 1" clean crushed gravel may be used in lieu of the above table.

4.4.2.3 SHEETING, BRACING, AND SHORING OF EXCAVATIONS. All excavations shall be sheeted, braced, and shored as required to protect the workers and existing utilities and improvements from sliding, sloughing, settling or other movement of the trench walls while the work is in progress. All such sheeting, bracing and shoring shall comply with the requirements of the Utah State Industrial Commission. All damage resulting from lack of adequate sheeting, bracing and shoring shall be the sole responsibility of the Contractor, and the Contractor shall affect all necessary repairs or reconstruction resulting from such damage.

4.4.2.4 BLASTING. The Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage, and use of explosives and protection of life and property.

All requirements contained in Section 2.9, Use of Explosives, shall be followed.

4.4.2.5 PIPE LAYING AND BEDDING. Pipe will be carefully inspected in the field by the Contractor and the County's Representative before and after laying. If any cause for rejection is discovered in a pipe before or after it has been laid, it shall be removed and replaced by the Contractor.

When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for, and expose the existing improvement before laying any pipe or conduit. The County's Representative shall be given the opportunity to inspect the existing pipe or conduit before the connection is made. Adjustments in line or grade of the connecting pipe which may be necessary to accomplish the intent of the plans will be made at this time.

Pipe shall be laid up grade with the socket bell, or collar ends of the pipe up grade unless otherwise authorized by the County's Representative. In general, the pipe will be laid in one direction only.

Pipe shall be laid true to line and grade, with uniform bearing under the full length of the barrel of the pipe. Suitable excavation shall be made to receive the bell or collar, which shall not bear upon the subgrade or bedding. Any pipe which is not true to alignment or shows any settlement after laying, shall be removed and re-laid to the proper grade and alignment.

A. REQUIREMENTS FOR LINE AND GRADE. All sewer and drainage pipe shall be installed to the defined line and grade within the following limits.

A.1 Variance from established grade shall be not greater than one - tenth ($1/10$) of a foot between manholes. Variance from established line shall be not more than one half foot between manholes. Any variances approved shall not impact the system design capacity and shall be approved by the County's Representative. Any variations shall not result in a level or reverse slope installation.

A.2 The invert elevations of each manhole and box at the inlet and outlet and distance between manholes and/or boxes shall be accurately verified by use of surveying instruments prior to pouring the floor or placing prefabricated manholes or boxes.

A.3 On main lines, invert elevations of each manhole inlet and outlet and the distance measurements between manholes shall be verified by use of surveying instruments or laser prior to installing precast manhole bases. For service laterals, grades may be verified by use of a carpenter's level or surveying instrument.

A.4 All sewer and drainage pipe systems shall be visually inspected for defects, displacement, proper workmanship, alignment and general compliance.

B. INSTALLATION OF PIPE. A groove shall be excavated along the bottom of the trench to receive the pipe. Bell holes shall be excavated so that only the barrel of the pipe receives bearing from the trench

bottom. Large rocks (over three (3) inches in least dimension) near the trench bottom shall be removed and the hole refilled with approved backfill in accordance with Table 4.5.

Water pipe shall not be deflected at the joint more than a maximum of three degrees, per joint, or as per the manufacturer's recommendation, whichever is more restrictive.

Sewer and drain pipe shall be laid up grade. All pipe installation shall proceed with joints closely and accurately fitted. Gaskets shall be fitted properly in place and care shall be taken in joining the pipes to avoid twisting the gaskets. Joints shall be clean and dry and a joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating joint surfaces to facilitate easy and positive joint closures. If adjustments to the position of a pipe length are required after being laid, the pipe shall be removed and rejoined as a new pipe. When pipe laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material. In addition to the above requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

C. SETTING OF BENDS, TEES, CROSSES AND REDUCERS. Bends, tees, crosses, and reducers shall be lowered into the trench, inspected, cleaned and joined to the pipe.

Restraining joints (megalug or equal) shall be used as per the standard drawings. Concrete thrust blocks may not be used as a restraining system for waterline mains or laterals without prior approval of the County Representative and water company. Reaction restraints or, when permitted by the County's Representative, thrust blocking, shall be applied at all bends and tees, and at points of reduction or at fittings where changes in pipe diameter occur.

The design of concrete thrust blocking shall be as shown in the standard drawings or as directed by the County Representative. The material used for thrust blocking shall be Class C concrete. Blocking shall be placed between solid undisturbed ground and the fitting to be anchored. The area of bearing shall in each instance be that required in the standard drawings or by the County's Representative. Unless otherwise directed by the County's Representative, the blocking shall be placed so that the pipe and fitting joints will be easily accessible for repair.

If a megalug retainer system cannot be used, a concrete thrust block system can be substituted, if approved by the County Representative, on a case by case basis.

D. PLUGGING OF DEAD-ENDS. Standard plugs shall be inserted into

the bells of all dead-end fittings. Spigot ends of fittings and plain ends of pipe shall be capped. When directed by the County's Representative, a concrete reaction or thrust block shall be provided at all plugged outlet fittings in the sizes indicated on the standard drawings or as directed by the County's Representative. The plugs and caps shall also be tied to the pipe with restraining joints. The number and size of rods shall be as specified.

E. SERVICE LINES. All service lines shall be installed in accordance with the details shown on the standard drawings.

F. PIPE TO BE KEPT CLEAN. All dirt and foreign matter shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean by means approved by the County's Representative during and after laying.

G. JOINTING PIPE SECTIONS. The sealing surface of the pipe, the bell to be joined, and the elastomeric gaskets shall be cleaned immediately prior to assembly, and assembly shall be made as recommended by the manufacturer. When pipe laying is not in progress, the open ends of installed pipe shall be closed to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, enough backfill shall be placed on the pipe to prevent floating. Any pipe that has floated shall be removed from the trench and the bedding restored. No pipe shall be laid when the trench or weather conditions are unsuitable for proper installations as determined by the County's Representative.

H. CUTTING PIPE. The pipe shall be cut in a neat manner without damage so as to produce a smooth end at right angles to the axis of the pipe. Existing transite AC pipe shall not be cut and should be removed and replaced by authorized trained personnel.

I. END PREPARATION. Pipe ends shall be cut square, deburred and beveled in accordance with the pipe manufacturer's recommendations.

J. PUSH-ON JOINTS. The push-on joint shall be a single elastomeric gasketed joint which shall be assembled by positioning the elastomeric gasket in the annular groove of the bell and inserting the spigot end of the pipe into the bell. The spigot end of the pipe shall compress the gasket radially to form a positive seal. The gasket and annular groove shall be designed, sized and shaped so that the gasket will resist displacement. Care shall be taken so that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell must be in accordance with the manufacturer's recommendations.

K. MECHANICAL JOINTS. The mechanical joint shall be a bolted joint of the stuffing box type, and installation recommendations from the manufacturer shall be followed. Each joint shall consist of:

K.1 A bell provided with an exterior gland having bolt holes or slots and a socket with an annular recess for the sealing gasket and the spigot end of the pipe. On all slotted holes the bolts will be supplied with square shoulders.

K.2 A sealing gasket.

K.3 A follower gland with bolt holes matching those in the fitting.

K.4 Tee bolts and hexagonal nuts of cor-ten metal.

L. PIPE BEDDING. Pipe shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded in accordance with the bedding details in the standard drawings.

Pipe bedding materials shall be deposited and compacted in layers not to exceed six (6) inches in compacted thickness. Deposition and compaction of bedding materials shall be completed simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors to the satisfaction of the County's Representative. All bedding materials shall be placed in the trench with hand tools, or other approved methods in such a manner that the bedding materials will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall conform to the requirements of Table 4.5 of these standards and shall be free from roots, sod, vegetation or other deleterious material.

In the event trench materials are not satisfactory for pipe bedding, imported bedding will be required. Imported bedding material shall be graded in accordance with Table 4.5, under "bedding material".

M. METER BOXES. All meter boxes shall generally be located behind the sidewalk. All meters will be provided with concrete collars. Any meter box damaged or covered during the construction operations shall be replaced and/or uncovered and raised to finish grade by the Contractor as determined by the County Representative.

4.4.2.6 BACKFILLING AND COMPACTION. Backfill shall include filling of all trenches to the original ground surface or final grading elevation as shown on the drawings, or otherwise directed by the County's Representative. Backfill shall be carefully placed around and over pipes and

shall not be permitted to fall directly on a pipe from such a height, or in such a manner as to cause damage. Backfill material shall be as required by Table 4.5 or as approved by the County's Representative and shall not contain any wood, grass, roots, broken concrete, frozen soil, asphalt chunks, trash or debris of any kind that may cause unequal settlement or improper consolidation.

The backfill in all utility trenches under proposed or existing roadways, curb and gutter, sidewalks and driveways shall be compacted to the equivalent of ninety five (95) percent of maximum dry density for granular soils or ninety (90) percent of maximum dry density for silty/clay soils.

A. INITIAL BACKFILL PROCEDURE. (Pipe Zone) Backfill of selected material, which shall conform to the requirements of Table 4.5, shall be placed carefully in eight inch non-compacted horizontal layers and compacted to a depth of twelve inches over the top of the pipe. During compaction of the initial backfill, special care shall be taken so as to not move the pipe, either vertically or horizontally. All backfill operations shall be performed in such a manner so as to avoid any damage to the pipe, valves, laterals, etc. In the event such damage or displacement occurs, such damaged or displaced pipe shall be removed and replaced with undamaged pipe on proper grade and alignment.

B. FINAL BACKFILL PROCEDURE. The backfill above a point twelve (12) inches above the top of the pipe shall be filled in horizontal layers six (6) inches thick or less with materials free from roots, vegetation or other deleterious material, or rocks, stones or boulders larger than three (3) inches in the greatest dimension.

C. MECHANICAL COMPACTION OF BACKFILL. The backfill shall be thoroughly compacted by mechanical compaction.

Structural and trench backfill shall be deposited in horizontal layers and compacted by the following method in such manner that the compacted material will be homogeneous and free from lenses, pockets, streaks, and other imperfections.

The materials shall be deposited in horizontal layers across the length or width of the excavation of not more than six (6) inches compacted thickness. The excavation and placing operations shall be such that the materials when compacted will be blended sufficiently to secure the best degree of compaction, impermeability and stability.

Prior to and during compaction operations, all backfill material shall have the required moisture content and shall be uniform throughout each layer.

If the moisture content is not optimum for compaction, the compaction operations shall be delayed until such time that the material has been brought to the required moisture content. When the material has been properly conditioned, it shall be compacted by using appropriate mechanical compaction equipment as indicated below or as otherwise approved by the County's Representative.

C.1 Vibrating rollers shall consist of a self-propelled roller with a vibrating steel drum of at least one (1) ton capacity. The roller shall have an effective rolling width of at least twenty four (24) inches and shall deliver a compaction force of at least seven hundred (700) pounds per square inch when vibrating.

C.2 Pneumatic rollers shall consist of a self-propelled roller with pneumatic tires arranged in a manner so as to provide a satisfactory compacting unit. The roller shall have an effective rolling width of at least thirty (30) inches and shall give a compaction force of at least five hundred (500) pounds per inch of width of tread when fully loaded. The tires shall be uniformly inflated.

C.3 Vibrating plates shall consist of a pneumatic vibrating plate attached to the boom of a backhoe and capable of compacting an area of at least three square feet. The plate and backhoe combination shall together be capable of exerting a compactive force of at least one thousand (1,000) pounds per square inch.

C.4 Hand compactors shall be used when hand-compacted methods are specified or required because the location of the area to be compacted does not permit the use of self-propelled mechanical compactors. Vibrating plates, "pogo-stick" tampers or other approved hand-compacting equipment shall be used.

C.5 Jetting and flooding or other water consolidation methods are not permitted.

4.4.2.7 TRENCHES ON HIGHWAYS AND STREETS. No work of any kind shall be performed in any public right-of-way without first obtaining an encroachment permit and any other required permits. Wherever any trenches will be in, or must cross any State road or any County road, alley or drainage way, the Contractor, or other responsible party, shall obtain any and all excavation and encroachment permits as are required for these crossings and shall become familiar with and abide by the rules and regulations of the Utah Department of Transportation and Washington County.

All Contractors or responsible parties excavating or encroaching over or

under any public right-of-way including roads, drainage way, easements or other public property shall first obtain a permit in compliance with the applicable local ordinances prior to excavating.

All asphalt cuts shall be made with a diamond or carbide-tipped masonry or asphalt cutting saw unless otherwise approved by the County's representative. No scarifier-tooth cuts, back-hoe or bucket rips will be allowed.

All backfilled trenches in roadways shall be patched with hot-mix asphalt within five days of initial excavation, unless otherwise directed by the County's Representative. All backfill shall be in accordance with these standards.

All concrete or asphalt surfaces damaged or cut in trenching operations or other work within the right-of-way shall be restored to an "as-good or better condition" in accordance with the provisions outlined in these standards.

During the entire trenching, backfilling and patching operations, the Contractor shall be required to observe all safety and traffic control procedures as outlined in these standards.

The Contractor shall be responsible for maintenance of the trench, patch, and related work for a minimum period of twelve (12) months from date of completion.

No more than two hundred (200) feet of trench shall be left unfilled at any time in one continuous run, unless otherwise approved by the County's Representative.

All streets and roads shall be kept free from dust and shall be open to through traffic. Approval to close the street must be obtained by the Contractor from the County representative or his designated representative. At least one-half (1/2) the width of any street or road shall be temporarily restored for use before excavation is commenced on the remaining portion of the street or road.

All excavation, backfilling and temporary resurfacing on any portion of any street or road shall be completed in one working day so that trenches are not left open or uncovered over night.

All requirements governing work within a right-of-way as contained in Section 2.5 (Barricades and Warning Signs - Work Area Protection) of these standards shall be adhered to.

All utility installations, i.e., gas, power, phone, cable T.V. and associated utilities, shall conform to the applicable test requirements contained within

these standards for earthwork, compaction, base course, bituminous surface course, concrete and other materials.

4.4.2.8 CLEANING OF SANITARY SEWER LINES. When sewer lines have been placed and the trench backfilled, the sewer lines shall be thoroughly cleaned, flushed, and tested prior to acceptance by the County's Representative. No debris shall be permitted to enter any sewer lines in service. All debris shall be removed from the sewerline and manholes. Methods of cleaning are subject to approval by the County's Representative and the sewer district.

4.4.2.9 CLEANING AND DISINFECTION OF WATER SYSTEMS. After being tested and prior to being placed in service, all lines shall be disinfected by chlorination. Prior to chlorination the entire line shall be flushed to ensure that all dirt or foreign objects have been removed from the line. Sufficient chlorine shall be added to ensure a residual of twenty five (25) parts per million in the water after twenty-four (24) hours standing in the pipe. Chlorine calcium hypochlorite dry chlorinating chemical solution may be used for this purpose. Methods of application shall be approved by the County Representative and applicable water company. Following chlorination, all treated water shall be drained and the pipeline thoroughly flushed with clean water.

All lines being disinfected shall be flushed after the specified twenty-four (24) hour contact period. Such flushing shall be continued until the water is free from excess chlorine. All lines being disinfected including hydrant laterals, branch lines, and dead-end mains shall be flushed. After final flushing the chlorine residual shall be tested by the water company. It is the contractor's responsibility to coordinate this test. The discharge of flushed water shall not cause erosion or damage to streets or other property. Procedures for discharge will be subject to the review and approval of the County's Representative and water company.

4.4.2.10 SPECIAL REQUIREMENTS.

A. CONNECTIONS TO EXISTING FACILITIES - DRY TAPS. All connections to existing facilities shall be approved by the County Representative and water company. The Contractor shall make the approved connections to existing facilities as shown on the drawings. Dry connections to existing facilities shall be made only at locations shown on the drawings and shall be made at such times which will cause the least inconvenience to the water user(s). Dry connections shall be planned to minimize the duration of any shut down. The Contractor shall notify the County Representative and water company at least two business days prior to beginning any connections to the existing facilities. When a connection to an existing water main is made, approximately four ounces of high test calcium hypochlorite (HTH) shall

be placed in the pipe at each point where the existing main is cut. All new pipe and fittings at such connections shall be swabbed internally with an approved chlorine solution. All connections shall be made in the presence of the water company representative.

Valves shall not be operated without a water company representative present. Existing facilities shall not be shut down for connections to new facilities without prior water company approval. In no case shall an existing pipeline be shut down for more than eight (8) hours in any twenty-four (24) hour period unless otherwise approved by the County Representative and water company.

The actual work plan and schedule for making a connection to an existing facility which requires an existing pipeline to be shut down, shall be submitted to the County Representative and shall be approved before the Contractor will be allowed to proceed. The Contractor shall notify, by a method approved by the water company, all affected water system customers at least twenty four hours prior to shut down. Valves at connections to all existing facilities shall be operated by the Contractor, but only in the presence of the water company representative. If the water will be shut off for an extended period of time, the water company may require the Contractor to supply water for the water company's customers.

B. CONNECTION TO EXISTING FACILITIES - WET TAPS The Contractor shall notify the County Representative and water company a minimum of two (2) business days prior to the time the wet tap is required. No wet taps shall be made without prior approval.

Prior to tapping the main, the tapping valve and fittings shall be properly installed and pressure tested and approved by the water company. The Contractor shall also provide all necessary equipment, labor and appurtenances necessary to complete the job.

4.4.3 QUALITY CONTROL. All underground pipelines shall be installed in accordance with these standards and tested as outlined below. These are minimum requirements and additional testing may be required.

4.4.3.1 TRENCH BACKFILL MOISTURE/DENSITY TESTING. Minimum testing of trench backfill shall be as follows:

Soil Proctor

One determination for each significant change in soil type as necessary to provide required compaction testing. Tests shall be ASTM D-1557 Method A or D (modified proctor).

Trench backfill moisture/
density determination -

Tests are required for trench backfill for every two hundred (200) lineal feet of trench or portion thereof and all service laterals, valve locations and manholes. Tests shall be run at the following trench elevations:

One test at top of pipe zone.

One test per two (2) feet of depth measured from the top of the subgrade to the top of the pipe zone. Tests shall be evenly spaced vertically through the trench with one (1) test at top of trench (bottom of subgrade).

Additional testing may be required by the County's Representative or soils testing laboratory to verify compaction.

Tests shall be according to ASTM D-1556 or D-2922 and D-3017. Moisture/density determinations shall be made in accordance with Section 3 of these standards. Proctors for all trench backfill compaction shall be determined using ASTM D-1557 modified proctor method.

4.4.3.2 SANITARY AND STORM SEWER LINE TESTING AND ACCEPTANCE. This subsection specifies requirements for the testing and acceptance of all sewer systems. Prior to testing, all sewer lines shall be cleaned. On main lines, invert elevations of the inlet/outlet of each manhole and the distance measurements between manholes shall be verified with surveying practices prior to installation of manhole floor. For service laterals, grades shall be verified by a carpenter's level or surveying instruments. All sewer trench compaction testing shall be completed and approved prior to performing air and deflection tests. The sewer lines, service laterals and manholes shall be tested for leakage and alignment in the presence of the County's Representative and sewer district as follows:

A. DISPLACEMENT TEST. The displacement test shall be conducted by the Contractor in accordance with the following procedure:

A light shall be flashed between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned or displaced pipe, or other defects, the defects identified by the County's Representative or sewer district shall be remedied by the Contractor. After cleaning and inspection have been completed, the line shall be tested for leakage.

B. AIR TESTING. An air test shall be performed on all sanitary sewer lines as directed by the County's Representative or sewer district. This

test applies to all types of pipe. When concrete pipe is used, it shall be pre-wetted prior to testing.

The reach of pipe to be tested shall be isolated by completely plugging all outlets in the section under test. Careful attention shall be given to blocking all plugs. Prior to installing the lower and upper plugs, any concrete pipe and manholes used shall be wetted to minimize any loss of air through the pipe or manhole walls as a result of permeability in the dry condition. One of the plugs used at the manhole must be equipped to control the air entry rate and to prevent the pressure from exceeding five (5) p.s.i.g. which shall be done by means of a blow-off valve set to operate at five (5) p.s.i.g.

After the plugs are installed (and any concrete pipe has been wetted) the air shall be allowed to slowly fill the pipe until a constant pressure of four (4) p.s.i.g. is maintained for at least two minutes. During the two-minute stabilization period, all plugs and exposed fittings shall be checked with a soap solution. If a leak is found, the air shall be bled off, the leak repaired and a new two minute stabilization period begun. When the temperature of the air has reached equilibrium with that of the pipe wall, the air pressure shall be brought to four (4) p.s.i.g. and the supply shall then be disconnected. When the pressure gauge reaches three and one-half (3 ½) p.s.i.g., a stop watch shall be started. The watch shall then be stopped when the pressure reaches two and one-half (2 ½) p.s.i.g. The time shown on the watch for a loss of one p.s.i.g. at an average pressure of three (3) p.s.i.g. is used to calculate the rate of air loss. The pipeline may be considered to have passed the air test successfully if the loss of air is not greater than a rate of 0.0030 cubic feet per minute per square foot of internal pipe surface. The following table shows the allowable time for the pressure to drop from three and one-half (3 ½) to two and one-half (2 ½) p.s.i.g. for respective pipe diameters.

**TABLE 4.6
AIR TESTING**

Pipe Diameter	Time		Pipe Diameter	Time	
	Min.	Sec.		Min.	Sec.
6-inch	3	0	18-inch	8	30
8-inch	3	45	20-inch	9	30
10-inch	4	45	21-inch	10	0
12-inch	5	45	24-inch	11	15
14-inch	6	30	27-inch	12	45
15-inch	7	0	30-inch	14	0
16-inch	7	30	36-inch	17	0

C. EXFILTRATION TEST. In lieu of the standard air test, the Contractor may make an exfiltration test in accordance with the following procedure:

The test section shall be plugged at both ends and the pipe subjected to a hydrostatic pressure produced by a head of water at a depth of three feet above the invert of the sewer at the upper manhole under test. In areas where ground water exists, the head of water shall be three feet above the existing water table.

For concrete pipe, the three foot head of water shall be maintained for a period of one hour to obtain full absorption of the pipe body and thereafter for a further period of one hour for the actual leakage test. For all other types of pipe, the three foot head of water shall be maintained for a period of one hour only. During the one hour test period the measured maximum allowable rate of exfiltration for any section of sewer, including service stubs, shall be as listed below.

**TABLE 4.7
EXFILTRATION TEST**

Sewer Main Diameter (inches)	Maximum Drop in Head in a 4-ft. Diameter Manhole (Non-taper sect.) per 100 ft. of sewer pipe	Maximum Allowable Leakage (Exfiltration) (Gallons/Hour/100 ft.)
6	0.1563 inch	1.2
8	0.2031 inch	1.6
10	0.2500 inch	2.0
12	0.3125 inch	2.4
15	0.3594 inch	2.8
18	0.4063 inch	3.2
21	0.4531 inch	3.6
24 or larger	0.5156 inch	4.0

When measurements indicate an exfiltration greater than the maximum allowable leakage, additional measurements shall be taken and continued until all leaks are located and the necessary repairs and corrective work have reduced the leakage in the section being tested below the maximum allowable by these standards. For purposes of the exfiltration test, the line between adjoining manholes will be considered a section and will be tested as such. The Contractor shall furnish the plugs and other material and labor for placing the plugs in the sewer and shall assist the sewer district in making all measurements required. The introduction of any substance into the testing water with the intent of sealing leaks will not be permitted.

When the results of the air test or the exfiltration test is not satisfactory,

repairs or pipe replacement shall be required until the sewer district is satisfied that the leakage requirements have been met. All repair methods and materials used shall be approved and accepted by the County's Representative and sewer district.

D. PVC DEFLECTION TEST. All PVC sewer pipe shall be tested for deflection with a mandrel. The mandrel shall be a rigid device sized to pass through a pipe having five (5) percent or less deflection. These allowances shall include deformations due to all causes (wall thickness variations, shipping, production, backfill, heat, etc.). The mandrel device shall be cylindrical in shape and shall comply with the manufacturer's recommendations.

The mandrel shall be hand pulled through all sewer lines. Any sections of sewer not passing the mandrel shall be uncovered and repaired by the Contractor. The Contractor shall re-round or replace the sewer to the satisfaction of the County's Representative and sewer district. All repaired sections shall be re-tested as noted above.

Deflection tests shall be conducted only after the final trench backfill is placed to final subgrade and compacted.

E. INSPECTION AND FLUSHING. Prior to final acceptance of each section of sanitary and storm sewer lines, all lines shall be flushed by the Contractor. All dirt and debris shall be prevented from entering the existing sewer system by means of water-tight plugs or other suitable methods.

Upon completion of the project, the sewer district will carefully inspect all sewers and appurtenances by means of camera and video. Any unsatisfactory work shall be removed and replaced in a proper manner. The invert of the sewer lines and manholes shall be left smooth, clean, and free from any obstructions throughout the entire line. All manhole rings and covers shall be adjusted to finished grade, concrete collars installed, and all sanitary sewer laterals shall be properly extended, capped and marked prior to acceptance of the sewer system.

F. MANHOLE LEAKAGE TEST. Sewer manholes located in areas of ground water or probable flooding or if their water tightness is suspect, as determined by the County's Representative or sewer district shall be tested for leakage prior to acceptance. The contractor shall perform all testing. Allowable leakage shall be one gallon per hour per manhole. At least two manholes shall be tested, and based on these tests and visual inspection of all manholes, additional tests may be required for other manholes. Any manhole which tests unsatisfactorily shall be repaired and retested until satisfactory results are obtained.

4.4.3.3 WATER SYSTEM TESTING AND ACCEPTANCE. The Contractor shall test all water mains prior to final acceptance. Testing shall be done in the presence of the County Representative and water company. When existing facilities must be included in the test and are determined to be faulty and not capable of holding test pressures, the existing facilities must be repaired prior to testing. When concrete thrust blocks are used, they shall be in place at least five days prior to initial filling of the line. (If high early strength concrete is used, three days will be required.)

A. PRESSURE TEST. After the pipe has been laid, including fittings, valves, corporation stops, services, and hydrants, and the line has been backfilled in accordance with these standards, each valved section, unless otherwise directed by the County Representative and water company, shall be subjected to a hydrostatic pressure test of not less than two hundred (200) pounds per square inch. A maximum of 1,000 linear feet of pipe shall be tested at one time. The duration of each such test shall be two hours. Water added to maintain the pressure shall not exceed 0.3 gallons per inch diameter per one thousand lineal feet of pipe being tested during the two hour test period.

Each valved section of pipe shall be slowly filled with water, and the specified test pressure measured at the lowest point of elevation. The pressure shall be applied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, and all necessary apparatus for the test must be furnished by the Contractor. Gauges and measuring devices must be approved by the County Representative and water company and the necessary pipe taps shall be made as directed. Before applying the specified test pressure, all air shall be expelled from the pipe by a method approved by the County Representative and water company.

Any cracked or defective pipes, fittings, valves, or hydrants discovered in the pressure test shall be removed and replaced with new materials in accordance with the standard specifications. The test shall be repeated until the water main passes the pressure test and is accepted by the County Representative and water company.

B. OPERATIONAL INSPECTION. At the completion of the project and in the presence of the County's Representative and water company, the Contractor shall operate all valves, hydrants, and water services to ascertain that the entire facility is in good working order; that all valve boxes are centered and valves are operational; that all hydrants operate and drain properly and that water is available at all meter boxes.

C. TEST RESULTS AND CERTIFICATES OF COMPLIANCE. Test results shall be submitted for pressure and operational testing in accordance with current County and water company requirements. Certificates of compliance from material suppliers may be required, at

the option of the County's Representative, for any materials not specifically covered herein.

4.5 ROADWAY CONSTRUCTION. This subsection covers roadway construction including subgrade, subbase, roadbase, recycled aggregate materials (RAM), prime coat, tack coat, plant mix bituminous surfaces (dense and open graded), construction staking and other related work.

4.5.1 GENERAL REQUIREMENTS. The Contractor shall furnish all labor, material, equipment, tools, transportation, traffic control and supplies required to complete the work in accordance with the approved plans and these specifications.

The Contractor shall arrange the work and shall place and dispose of the materials being used so as not to interfere with the public during the course of the project. The Contractor shall join the new work with that of existing in an acceptable manner and shall perform all work in proper sequence.

The Contractor shall provide and maintain or have provided for, all necessary work zone traffic control in accordance with the requirements of Section 2.5 of these specifications. The Contractor shall also maintain the job site and all adjoining private and public areas in a clean, safe manner. This maintenance shall constitute continuous and effective work prosecuted day-by-day, with proper equipment and adequate work forces to keep all areas related to and adjoining the job site in a condition satisfactory to the County's Representative. If, at any time, the Contractor fails to comply with these provisions the County's Representative will immediately notify the Contractor of such n.

If a condition develops due to a lack of maintenance by the Contractor that is dangerous to public safety, the Contractor shall proceed to immediately remedy the condition with whatever means are available. The project may be stopped until these corrections are made. The cost of the corrective remedy will be the Contractor's responsibility

4.5.2 CONSTRUCTION STAKING. Construction stakes shall be furnished and set, establishing lines and grades for roadway excavation including, but not limited to all cut and fill slopes, finished subgrade, finished subbase and finished roadbase grades for streets, curb & gutter, cross-gutters, sidewalks, drive approaches, any contiguous structures and utilities (to help prevent conflicts of location). In development related projects the Developer and his Engineer shall be responsible for all surveying and the accuracy thereof.

The line and grade stakes shall be, whenever possible, off-set from the construction area a minimum of five feet, and shall show the stationing (corresponding with the approved plans), off-set distance, required cut or fill to the finished grade, flow line, or Top Back of Curb (TBC) as indicated on the approved plans. Grade stakes with hubs set to the finished grade of the

subgrade shall be painted appropriately. Stakes with hubs set to the finished grade of the subbase or roadbase shall be painted appropriately. Plastic "whiskers" may be used in connection with painted hubs. All stakes and grades shall be set by appropriate methods under the direction of a professional engineer or licensed surveyor. The Contractor and the County Representative should be provided with copies of the cut sheets generated during construction staking. Cut sheets shall include roadway stationing, reference elevations, grade elevations, etc.

The line and grade stakes and cut sheets along with the most current set of approved plans shall constitute the field control by which the work shall be executed.

The Contractor shall be responsible for preserving property markers, corner survey markers, construction survey stakes and marks for the duration of their usefulness.

If any construction survey stakes or markers are lost or disturbed and need to be replaced, such replacement shall be done at no expense to the County. At no time shall a permanent monument be removed without prior authorization by the County Surveyor. When construction work encounters such monuments, the County Surveyor should be contacted immediately.

4.5.3 GRADE CONTROL SYSTEMS. Non-contact grade control systems may be used to establish the roadway elevations of subgrade, subbase and roadbase on public streets providing the following conditions are met.

A. The system shall be equipped with a "self diagnostic" function that continuously monitors all system functions and shuts the system down if an error in the system occurs. It shall also be equipped with a "thermistor" to electronically compensate for differences in air and ground temperature with a minimum operating range not less than zero to 160° F.

B. The system shall meet the following minimum specifications:

- Blade slope sensor resolution 0.01% slope
- Main fall sensor resolution 0.01% slope
- Rotation sensor resolution 0.1 degree
- Tractor grade controller +/- 0.015 foot accuracy
- Cross-slope resolution 0.1% slope or 0.01 foot/10 foot
- Cross-slope system accuracy 0.02 foot/10 foot
- C. A system meeting the above requirement must be properly installed on a "tight"* properly maintained motor-grader.
- * Meeting the equipment manufacturer's service specification tolerances for all controlling surfaces and connecting points that affect the ability of that specific type of equipment to provide proper grade control.

With all the above conditions met the system will be permitted to be used, providing a preset grade and line for curb & gutter, edge of pavement or curb grade line has been established by the Engineer.

The County's Representative has the right to prohibit the use of such equipment, if in his opinion; the equipment has not been properly maintained or is not being properly operated.

4.5.4 GEOTECHNICAL INVESTIGATION. A geotechnical investigation shall be conducted under the direction and control of a Geotechnical Engineer experienced in flexible pavement design. The investigation shall include a thorough exploration and sampling program of the subgrade to determine the nature and engineering properties of the on-site soils within the roadway construction areas. The minimum sampling and testing requirements shall be as outlined in Section 3.2.5 and where otherwise outlined in these specifications.

The structural details shown on the plans and/or Standard Drawings, and Table 4.8 are minimum requirements. The actual structural section for each roadway shall be designed by accepted engineering design methods for flexible pavement (current AASHTO, UDOT, or Caltrans methods are acceptable) and must be approved by the County Representative prior to construction. Required subgrade soil properties shall be obtained from an on-site geotechnical investigation. Required traffic design traffic information is provided in Table 4.8. When, in the opinion of the County representative the traffic information listed is inappropriate for the street under consideration the Traffic Index will be adjusted accordingly.

4.5.5 ROADWAY SUBGRADE. This subsection shall govern the preparation of natural, filled or excavated material prior to placement of subbase. The preparation of subgrade shall extend a minimum of two feet beyond the proposed construction limits. This includes roadways, curb & gutters, drive approaches, sidewalks or any other roadway structures.

4.5.5.1 PREPARATION. The subgrade soils shall be prepared by scarifying and processing to a minimum depth of one (1) foot unless otherwise recommended by the approved geotechnical study.

Unsuitable material found below the processing depth such as saturated soils from groundwater, expansive soils, soluble soils, deleterious and/or organic materials shall be addressed by a Geotechnical Engineer who shall provide a written recommendation to the County's Representative for approval prior to performing any work in the areas being addressed.

TABLE 4.8
Minimum Roadway Structural Requirements

Classification	Traffic Index	Roadway Minimum Asphalt Pavement Thickness (inches)	Roadway Minimum Roadbase Thickness (inches)	Sidewalk Minimum Concrete Thickness (inches)	Sidewalk Minimum Roadbase Thickness (inches)	Driveway Minimum Concrete Thickness (inches) within R/W	Driveway Minimum Roadbase Thickness residential (inches) within R/W
Residential	5	3 (1)	6	4	4	6	6
Collector	6	3 (1)	8	4	4	6	6
Arterial	8	4	8	4	4	8	8

(1) Asphalt pavements containing more than 1% gypsum ($\text{CaSO}_4 + 2\text{H}_2\text{O}$ calcium sulfate, dihydrate) shall be a minimum of 3 1/2" thick; consisting of 2 1/2" thickness of 3/4" dense-graded asphalt base course containing no more than 2% gypsum and 1" thickness of 1/2" dense-graded asphalt wearing course with less than 1% gypsum.

4.5.5.2 TOLERANCES. When subbase material is placed on the subgrade the subgrade tolerance shall not vary more than 0.10-foot from the specified grade and cross-section. However, when roadbase or recycled aggregate materials (RAM) is placed on the subgrade the subgrade tolerances shall not vary more than 0.05-foot from the specified grade and cross-section.

4.5.6 SUBBASE - CLASS I AND CLASS II. All gravel pits supplying aggregate shall be UDOT approved pits. Subbase for all roadways and associated areas shall consist of select materials, either natural or crushed. Aggregate wear shall be less than fifty (50) percent when tested by AASHTO T-96. The material passing the #40 sieve shall be non-plastic per AASHTO T-90. The subbase shall contain no more than three (3) percent gypsum or any other deleterious or organic materials by weight.

Prior to delivering any subbase to any site the supplier shall submit, in writing, a job-mix gradation to the County representative for approval. The job-mix gradation shall have definite single values for the percentage of aggregate passing each specified sieve based on the dry weight of the aggregate. Dry weight values shall fall within the band limits shown in Table 4.9.

Annual job-mix gradations shall be submitted in writing to the County representative for approval prior to January 31 each calendar year or upon selection of new aggregate sources. Any revisions to the approved job mix gradations shall fall within the requirements listed above.

If a supplier does not have an approved job-mix gradation that is current for the aggregate source or calendar year, the "Ideal Gradation" in Table 4.9 will apply.

The subbase mixture placed on projects during one day's operation shall come from a single source. Intermixing from more than one source will not be permitted.

Subbase material shall be deposited and spread in uniform lifts not to exceed eight (8) inches compacted thickness for Class I and six (6) inches compacted thickness for Class II without segregation of size. Each layer shall be compacted for the full width and depth by mechanical means of compaction. When mixing, moistening and placing subbase the moisture content shall be not less than two (2) percent below optimum. However, caution shall be used to avoid over watering to a state of instability. Alternate blading and rolling will be required to provide a smooth, evenly moistened and uniformly compacted course true to cross-section and grade. Locations inaccessible to rolling shall be compacted with mechanically operated hand tampers. The subbase shall be compacted to not less than ninety five percent maximum dry density as determined by ASTM D1557-78 or AASHTO T-180 Method D. Subbase tolerances when compacted shall not vary more than 0.05-foot from the specified grade and cross-section.

**TABLE 4.9
SUBBASE AGGREGATE GRADATION**

PERCENTAGE OF TOTAL AGGREGATE PASSING					
SIEVE SIZE		CLASS I BAND LIMITS	IDEAL GRADATION	CLASS II BAND LIMITS	IDEAL GRADATION
	6"	100	100	--	--
	3"	90 - 100	95	100	100
	2"	80 - 100	90	90 - 100	95
	1"	70 - 90	80	70 - 90	80
	1/2"	51 - 75	63	51 - 75	63
	#4	31 - 65	48	31 - 65	48
	#16	16 - 40	28	16 - 40	28
	#200	2 - 12	7	2 - 12	7

4.5.7. UNTREATED ROADBASE - ONE INCH AND THREE-QUARTER INCH.

All gravel pits supplying aggregate shall be UDOT approved pits. Roadbase for all roadways and associated areas shall consist of select materials, natural and/or crushed. Coarse aggregate shall be all material retained on the #4 sieve, and shall be crushed stone, crushed gravel, or crushed slag with a minimum of forty (40) percent fractured faces per Federal Lands Highway (FLH) designation T-506-94. Fine aggregate may be a natural, or manufactured, product and shall

pass through a #4 sieve. All aggregates shall be clean, hard, tough, durable and sound containing no more than two (2) percent gypsum and be free from other deleterious and/or organic materials and harmful adherent coatings.

Aggregate wear shall be less than fifty (50) percent when tested by AASHTO T-96 and the material passing the #40 sieve shall be non-plastic per AASHTO T-90. The dry-rodded unit weight shall be at least seventy five (75) pounds per cubic foot per AASHTO T-19.

Prior to delivering any roadbase to any site, the supplier shall submit, in writing, a job-mix gradation and a standard aggregate gradation plot to the County representative for approval. The job-mix gradation shall have definite single values for the percentage of aggregate passing each specified sieve based on the dry weight of the aggregate. Dry weight values shall fall within the band limits shown in Table 4.10, and provide a uniform curve when plotted on a standard aggregate gradation chart. The County representative has the right to request modification to the job-mix gradation to provide an acceptable curve. The accepted job mix will then become the target gradation for the aggregate source for the calendar year.

Annual job-mix gradations shall be submitted in writing to the County representative for approval prior to January 31 each calendar year, or upon selection of new aggregate sources. Any revisions to the approved job-mix gradation shall fall within the requirements listed above.

If a supplier does not have an approved job-mix gradation that is current for the aggregate source, or calendar year, the "Ideal Gradation" in Table 4.10 will apply.

The roadbase placed on a project during one day's operation shall come from a single source. Intermixing from more than one source will not be permitted.

Roadbase shall be placed in layers compatible with the equipment and not exceeding six (6) inches in compacted thickness. Where the required thickness is more than six (6) inches the roadbase shall be spread and compacted in two (2) or more layers of approximately equal thickness. Each layer shall be compacted for the full width and depth by mechanical means. When mixing, moistening and placing roadbase the moisture content shall be not less than two (2) percent below optimum. Care shall be used to avoid overwatering. Alternate blading and rolling will be required to provide a smooth, evenly moistened and uniformly compacted course true to cross-section and grade. Locations inaccessible to rolling shall be compacted with mechanically operated hand tampers. The roadbase shall be compacted to not less than ninety five (95) percent maximum dry density as determined by ASTM D-1557 or AASHTO T-180 method D. Roadbase tolerances when compacted shall meet or exceed the required minimum thickness and shall not vary more than 0.02 foot from the specified grade and cross-section at the time the asphalt pavement is placed.

When the roadbase surface is used to convey traffic, or is left unpaved for an extended period of time, the contractor shall preserve the integrity and grade and an asphalt prime coat meeting the requirements in Section 4.5.8 shall be applied. When asphalt prime is not used, the contractor shall maintain the roadbase moisture, structural integrity and finish, to the finished tolerances of this subsection.

**TABLE 4.10
ROADBASE AGGREGATE GRADATION**

PERCENTAGE OF TOTAL AGGREGATE					
Sieve Size		1 Inch Band Limits	Ideal Gradation	3/4 Inch Band Limits	Ideal Gradation
	American Standard				
	1"	100	100	--	--
	3/4"	--	--	100	100
	1/2"	79 - 91	85	--	--
	3/8"	--	--	78 - 92	85
	#4	49 - 61	55	55 - 67	61
	#16	27 - 35	31	28 - 38	33
	#200	7 - 11	9	7 - 11	9

4.5.8 PRIME COAT. Prime coat is generally not required on any County roadways unless otherwise required by the County representative. If a prime coat is used, then the air temperature must be 70°F and rising. This work shall consist of preparing and treating an existing aggregate base with bituminous material and blotter material, if required. The type and grade of bituminous material shall be MC-70 liquid asphalt, unless otherwise approved by the County's Representative.

The Contractor shall provide equipment for heating and applying the bituminous material. The asphalt distributor shall be so designed, equipped, maintained and operated that bituminous material will be applied uniformly on variable widths of surface at readily determined and controlled rates.

Bituminous material shall not be applied on a wet surface that has free standing water, or when the atmospheric and surface temperature is less than 70° F or when weather conditions, in the opinion of the County's Representative, would prevent the proper application of the prime coat.

Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. When traffic is maintained, not more than one-half of the width of the section shall be treated in one application. Traffic will not be allowed on the treated surface until the bituminous material is absorbed and will not adhere to the vehicle tires. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Skipped areas or deficiencies shall be corrected.

Application rate shall be 0.25 gallon per square yard, or as directed by the County's Representative. At the time of placement, the temperature of the liquid asphalt shall be uniform and not less than 120° F or more than 180° F.

If the bituminous material fails to penetrate within forty-eight hours, blotter material shall be spread as required to absorb any excess bituminous material. All loose blotter material shall be completely removed from the treated areas prior to placing surfacing material. Prior to placing asphalt concrete, additional prime coat shall be applied as directed by the County's Representative to areas where the prime coat has been damaged, and loose or extraneous material shall be removed.

Sand blotter material shall be clean and meet the following gradation requirements.

GRADATION REQUIREMENTS
Percentage by Weight

<u>Sieve Sizes</u>		<u>Passing Sieve</u>
½ Inch	100
No. 4	90 - 100
No. 16	30 - 75
No. 200	0 - 12

4.5.9 TACK OR FOGSEAL COAT. This work shall consist of preparing and treating an existing bituminous or concrete surface with asphaltic emulsion. The type and grade of bituminous material shall be SS-1h asphalt emulsion, unless otherwise directed.

Asphalt emulsion used as a tack coat between courses of plant mix surface, or over an existing surface, shall be prepared for application by using warm water to cut back the emulsion in the quantity of fifty (50) percent of the emulsion by weight.

Bituminous material shall be applied to the width of the section to be tacked by means of a pressure distributor in a uniform, continuous spread. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Skipped areas or deficiencies shall be corrected.

The Contractor shall provide equipment for heating and applying the bituminous material. The asphalt distributor shall be so designed, equipped, maintained and operated that bituminous material will be applied uniformly on variable widths of surface at readily determined and controlled rates.

Application of tack coat may occur only when the surface and air temperature is 50° F and rising. The surface shall be clean, dry, free of irregularities, and shall be smooth and uniform.

At the time of placement, the temperature of the asphaltic emulsion shall be uniform and not less than 75 degrees F or more than 130 degrees F. The tack shall be applied at a rate of 0.05 to 0.10 gallon per square yard. The rate of application may be adjusted by the County's Representative.

4.5.10 DENSE-GRADED ASPHALT AND RECLAIMED ASPHALT PAVEMENT (RAP). This work shall consist of mixing, laying and compacting an asphalt course of one or more layers composed of aggregate, asphalt cement, applicable additives and lime, as required. All materials shall be mixed at a central mixing plant (plantmix). When a $\frac{3}{4}$ " mix design is used for a surface course, a fogseal shall be applied. The proportion of reclaimed asphalt pavement (RAP) used in the mix shall not exceed fifteen (15) percent.

4.5.10.1 ASPHALT DESIGN. Prior to delivering any plantmix asphalt to any site, the supplier shall submit, in writing, a job-mix formula to the County representative for approval. The job-mix formula shall be determined by a testing laboratory under the direction and control of a Registered Professional Engineer, based on tests performed in accordance with the "Marshall Method of Mix Design" as described in the Asphalt Institute Manual No. 2 latest edition. The job-mix formula asphalt shall satisfy all design criteria as shown in Table 4.11.

Annual job-mix formulas, together with test reports, shall be submitted in writing to the County representative for approval prior to January 31 each calendar year, or upon selection of new job-mix formulas or when there is a change in the source of materials or a change in the percentage of RAP used in the mix. The test report shall give the recommended asphalt content and the values for unit weight, stability, flow, air voids, voids filled with aggregate, voids in mineral aggregate, and indirect tensile strength. Any revisions to the approved formula shall fall within the requirements listed above.

**TABLE 4.11
MARSHALL DESIGN REQUIREMENTS**

TRAFFIC CATEGORY*	I		II	
ASTM D-1559 (number of blows)	75		50	
TEST PROPERTY	MIN	MAX	MIN	MAX
MARSHALL STABILITY, LB.	1500	--	1200	--
FLOW, 0.01 IN	8	16	10	18
AIR VOIDS: PERCENT	3	5	3	5
VOIDS IN MINERAL AGGREGATE (VMA)	13	17	13	17
FRACTURED FACES RETAINED ON THE NO. 4 (4.75 mm) SIEVE PER FLH DESIGNATION: T-506-94 2.1	100%	---	75%	--
SAND EQUIVALENT PER AASHTO T-176-86 (1993) 4.3.2, 4.3.3	55	---	40	--
WEAR TEST AASHTO T-96	---	30%	---	30%
DRY-RODDED UNIT WEIGHT AASHTO T-19	AM. STD. 75 pounds per cubic foot minimum			
STRIPPING TESTS: AASHTO T-283 ASTM D-4687 including Note 5	Shall be used to determine the required amount of hydrated lime or anti-stripping agent in the asphalt. The mix design shall have a tensile strength minimum of 70 percent.			

* Traffic Category I applies to arterial streets or truck routes with a Traffic Index of seven (7) or more.

Traffic Category II applies to streets with a Traffic Index of less than seven (7).

4.5.10.2 ASPHALT CEMENT. Viscosity graded asphalt cement shall meet AASHTO designation M-226. Viscosity is to be measured at 140°F when used in pavement construction. The asphalt cement shall be homogeneous, free from water, and shall not foam when heated to 350° F. Sampling and testing of asphalt cements shall be in accordance with the following AASHTO Standard Methods:

- Sampling

T40

- Viscosity at 140°F T202
- Viscosity at 275°F T201
- Penetration T49
- Flash point (COC) T48
- Solubility in bituminous materials T44
- Thin-film oven test T179
- Ductility T51
- Spot test T102
- Rolling thin film oven test T240
- Water T55

The asphalt cements shall conform to the requirements given in Table 4.12.

TABLE 4.12
Paving Grade Liquid Asphalt Requirements

	AC-10	AC-20	
Viscosity: 140°F poises	1,000 ± 200	2,000 ± 400	
Viscosity: 275°F, Cs-minimum	250	300	
Penetration: 77°F, 100g, 5 sec-min.	80	60	
Flash Point: COC, (°F) -minimum	425°	450°	
Solubility in trichloroethylene: percent-minimum	99.0	99.0	
Tests on residue from thin-film oven test:			
Loss on heating: percent - maximum (1)	0.5	0.5	
Viscosity: 140°F, poises-maximum	4,000	8,000	
Ductility: (77°F, 5 cm per minute), cm-minimum	75	50	
Spot test (when and as specified) (2) with: Standard naphtha solvent	Negative for all grades		

1. The use of loss on heating requirement is to be used only if required by the County representative.
2. The use of the spot test is to be used only if required by the County representative.

4.5.10.3 SHIPMENT OF ASPHALT MATERIAL. Asphalt cement shall be uniform in appearance and consistency and show no foaming when heated to the specified loading temperature. Shipments of asphalt shall not be

contaminated with any other type or grade of asphalt material. A bill of lading shall accompany each shipment of material and shall include the following information:

- Type and grade of material.
- Type and amount of additives used, if applicable.
- Destination.
- Consignee's name.
- Date of shipment.
- Truck identification.
- Loading temperature.
- Net weight or net gallons corrected to 60°F.
- Specific gravity.
- Bill of lading number.
- Manufacturer of asphalt material.

4.5.11 HYDRATED LIME FOR ASPHALT MIXTURE. The physical properties of hydrated lime shall conform to ASTM C-1097, subparagraph d.1; use test method ASTM C-110, paragraph 6.

The water used in saturating the aggregate to be coated shall be potable or water that is clean and free of dirt, silt and other damaging material. The aggregate bulk specific gravity (saturated-surface-dry (SSD)) shall be not less than one and one-half (1½) percent or more than three (3) percent using AASHTO T-85 for the coarse aggregate retained on a No. 4 sieve and AASHTO T-84 for the fine aggregate passing the No. 4 sieve. Hydrated lime shall be applied at a rate determined during the Marshall Design requirements in Table 4.12, unless otherwise directed by the County representative. Two options for coating the aggregate with lime are as follows:

A. Aggregate shall be monitored for SSD by taking a belt cut between the stockpile and the pugmill or drum. The pugmill or drum shall be equipped with metering devices that will introduce the required amount of hydrated lime and water into the mixer to produce an aggregate SSD of one and one-half (1½) percent to three (3) percent.

B. Use of lime slurry of one (1) part lime and three (3) parts water by volume may be used, if the plant is equipped with a mixing chamber that can maintain the lime suspension in the slurry. Spraybars for introducing the required quantity of slurry into the mixer shall be equipped with a positive shutoff. If this option is used, the aggregate stockpile shall be maintained at two (2) percent SSD.

Asphalt plants shall provide a positive signal system that automatically closes down the cold feed when the appropriate amount of hydrated lime and water ceases to be introduced into the aggregate. This shall be accomplished by the use of interlocked and synchronized metering devices

and feeders. The plant shall be equipped in such a way that the quantity of hydrated lime incorporated into the mix can be readily checked at any time.

4.5.12 AGGREGATE. The requirements for crushed rock, rock dust, gravel, stone, slag, and sand are included in this subsection. All aggregate shall be clean, hard, sound, durable, and uniform in quality. The quality of soft, friable, thin, elongated, laminated pieces and disintegrated materials will be determined by the supplier's professional Geotechnical Engineer at the time the mix design is submitted, at which time the County's Representative will have the option to approve or reject the material. Organic matter, oil, alkali or other salts shall not exceed two (2) percent total weight. In the surface course this material may be restricted to less than one (1) percent by weight.

A. Aggregate for three-quarter (3/4) inch Category I (NR), (see Table 4.13) shall be one hundred (100) percent crushed material (all manufactured). This is considered a non-rutting (NR) mix.

B. Coarse aggregate for three-quarter (3/4) inch standard and one-half (1/2) inch Category II (see Table 4.13) shall be retained on the No. 4 sieve and shall have no less than seven-five (75) percent fractured face material as defined in FLH T 506-94 2.1.

C. Fine aggregate for other than the three quarter (3/4) inch NR, may be a natural or manufactured product. It shall pass the No. 4 sieve. It shall be clean, hard-grained angular, non-plastic, and have no more than two percent by weight of organic matter or other detrimental substances, including gypsum.

1. Surface courses, or asphalt wearing courses, shall be free from organic materials and contain less than one percent by weight of soluble minerals, such as gypsum, and phosphates.

**TABLE 4.13
DENSE-GRADED ASPHALT AGGREGATE GRADATION**

PERCENT OF TOTAL AGGREGATE PASSING (DRY WEIGHT)				
TRAFFIC CATEGORY		I	II	
		3/4 inch NR*	3/4 inch std.*	1/2 inch
SIEVE SIZE (American Standard)				
	1 inch	---	---	---
	3/4 inch	100	100	---
	1/2 inch	74 - 99	---	100
	3/8 inch	69 - 91	75 - 91	---
	#4	49 - 65	46 - 62	60 - 80
	#8	33 - 47	---	---
	#16	21 - 35	22 - 34	28 - 42
	#50	6 - 18	11 - 23	11 -23
	#200	2 - 6	5 - 9	5 - 9

* When a 3/4" mix design is used for a surface course, a fogseal shall be applied.

4.5.13 STORING, MIXING AND SHIPPING OF PLANT MIX BITUMINOUS PAVEMENTS. Hot mix plants may be batch or drier-drum type plants (with not less than four aggregate bins). All storing, mixing, and shipping of plant mix bituminous asphalts shall conform to current UDOT and AASHTO requirements.

4.5.14 ASPHALT CONCRETE SURGE AND STORAGE SILOS.

Storage silos shall be well insulated and equipped with heated discharge cones and well sealed discharge gates. Dense-graded asphalt may be stored up to forty eight (48) hours in silos with heated cones, and seventy two (72) hours with heating of the silo vertical walls and cone.

Storage silos may be used for storage or surge purposes, but under no circumstance may a surge silo be used for storage. Either silo must be equipped with high and low indicator systems.

4.5.15 SHIPPING ASPHALT MIXTURES. Trucks used for hauling mix shall have tight, clean, smooth beds which are treated to prevent the mix